Six-Sided Bed for Fall and Injury Prevention in Hospitals and Home Hospital Settings

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Word Count:3333

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Background and Rationality

Imagine if hospital beds were designed with the same level of innovation and attention to their fundamental purpose as airplanes or spacecraft. While the aviation and automotive industries have advanced safety and efficiency for travel and commuting, and home beds are crafted for rest and rejuvenation, it’s striking that we have not applied such purpose-driven design to hospital beds—where patients spend 80-100% of their time according to studies, in a setting meant for more caring purposes than homes. Given that hospitals have a more caring role than homes, the design should address both caregiver needs and a more patient-centric approach. Instead, we have stuck with outdated, rectangular beds and the spaces designed around them, borrowed from other industries. This gap presents a significant opportunity to rethink hospital bed design and the surrounding space to improve patient outcomes, healthcare quality, and safety.

Our Six-Sided Bed System changes this paradigm with a people-centered approach to innovation. We are not just designing a new bed but reimagining the entire space around it. Our approach is inspired by natural structures like beehives and the womb, as well as principles from aviation motion logistics, the transparency, purity, and effectiveness of lactation and swarm intelligence. We believe that a bed should be more than just a piece of furniture—it should be a central element in patient care and safety.

The Six-Sided Bed System and its tools integrate several key strategies for comprehensive fall prevention. The bed, which rotates, tilts, and adjusts in height and angle, automatically adapts based on routine assessments, especially at night. Our comprehensive AI-driven questionnaire includes health and medication management to mitigate fall risks and also assesses emotional well-being and physical therapy needs through the happiness system. In this project, we evaluate the effectiveness of 12 Six-Sided Beds in a urology unit, aiming to minimize falls and injuries by 50% and improve safety and care quality using AI-driven questionnaires and a scoring system for fall risk assessment, with recommendations reviewed and signed by an MD. This data-driven methodology ensures precision and adaptability.

The bed’s unique structure-within-a-structure design features grooves and edges for support, eliminating the need for traditional bed rails. It also incorporates adaptive lighting for non-verbal communication, EquiSafe—an integrated wheelchair system for patient mobility and comfort, and a ventilation system for drying and temperature regulation. Our three-section approach addresses health, pharmaceutical needs, and happiness using AI-driven tools to support these areas and ensure effective fall risk management.

Stakeholders, teams, and patients are actively involved throughout the project, with space walks by project leaders ensuring continuous feedback and improvement. This innovative approach not only aims to enhance patient-centered, safe, efficient, effective, equitable, and timely quality care with a patient-side of change approach

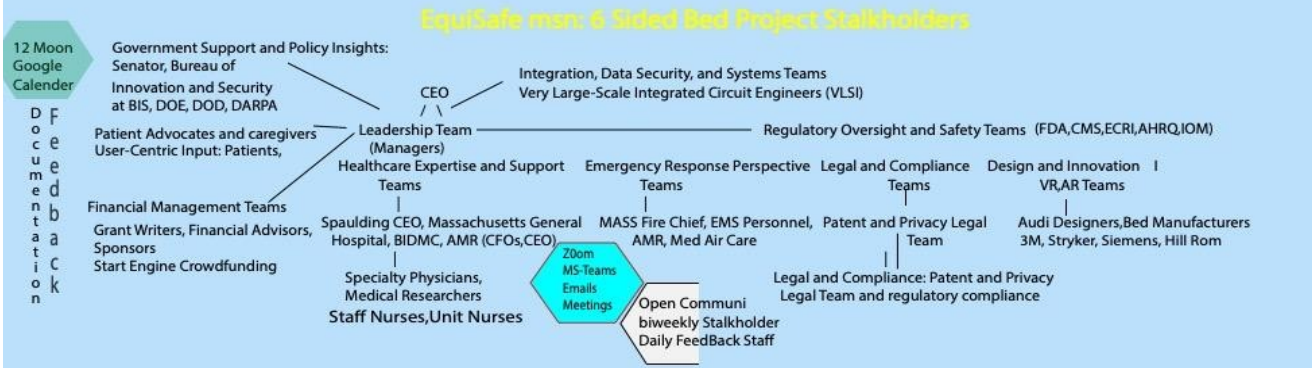
but also sets a foundational vector with magnitude and direction for healthcare operational design, guiding us toward a North Star of resilience and adaptive resilience. Now, imagine scaling a hundred thousand rectangular beds amid a health crisis, such as a pandemic, or managing one million staffed beds across 404 health systems in the U.S., or even more in home hospital settings. The limitations of outdated global healthcare's inequitable primary structure—rectangular beds and the cluttered spaces they create—become apparent when addressing complex communications and diverting focus and time away from patients, leading to fundamental challenges like falls and injuries. In contrast, our Six-Sided, resilient hexagonal bed system serves as a functional, disciplined, systems-centric vector and a healing messenger between patients and caregivers, providing an equitable, patient-centric platform in a time- and clutter-free space with adaptive capabilities. This offers sophisticated, adaptable solutions for such scenarios and beyond through non-destructive manipulation of current healthcare systems akin to the work of a great artist.

Problem Statement

Traditional hospital bed designs, particularly the conventional rectangular structures and bed rails, have led to significant patient safety issues. Over an eight-year period, there were approximately 36,900 adult injuries in U.S. hospitals due to bed-related incidents (U.S. Consumer Product Safety Commission, 2013). From 1985 to 2013, the FDA recorded 531 deaths and 151 injuries related to hospital beds (U.S. Food and Drug Administration, 2013). Additionally, hospitals experience an alarming rate of 3–5 falls per 1,000 bed-days, with annual estimates of 700,000 to 1 million falls in U.S. hospitals (Agency for Healthcare Research and Quality, 2019). These issues arise from inherent flaws in the traditional rectangular bed design, which often exacerbates patient risks rather than mitigating them. Conventional fall risk assessment methods are outdated and ineffective, leading to high fall rates and putting both patients and staff at risk (Oliver, Healey, & Haines, 2010). The failure of traditional bed designs to address these issues highlights the need for innovative solutions that can transform patient care environments. Our project seeks to address these challenges through a groundbreaking redesign of the hospital bed and the space around it especially the floor tiles.

Aim Statement

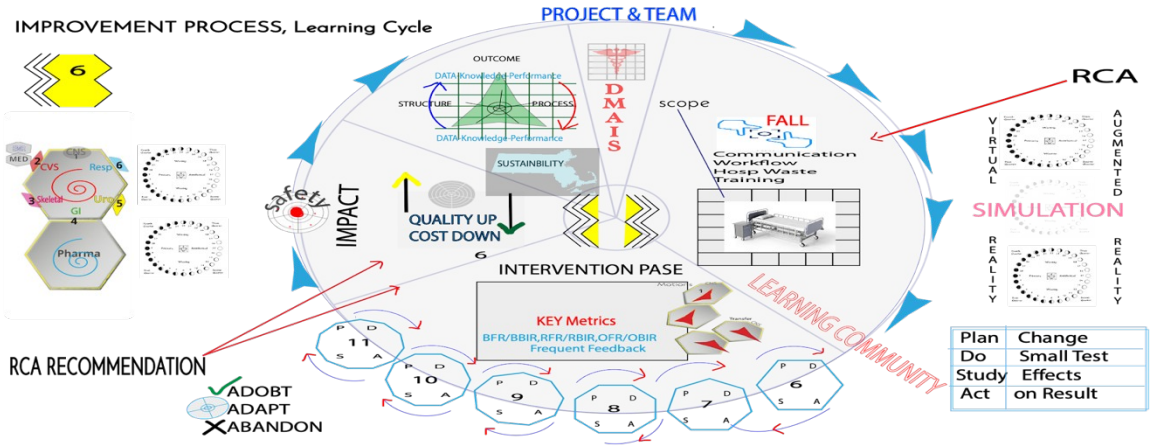
Our primary aim is to achieve a 50% reduction in fall rates and related injuries using the Six-Sided Bed System in the Urology Unit at Spalding Healthcare and AMR Martha's Vineyard, Boston. We will measure success through a combination of fall incident data, injury reports, and patient feedback over a 12-month period. Based on the results of the pilot phase, we will plan for future expansion to other units, cities, and states.


EquiSafe msn: 6 Sided Bed Project Stalkholders
12 Moon Google Calender
Documentation
Feedback
Government Support and Policy Insights:
Senator, Bureau of Innovation and Security at BIS, DOE, DOD, DARPA
CEO
Integration, Data Security, and Systems Teams
Very Large-Scale Integrated Circuit Engineers (VLSI)
Patient Advocates and caregivers
User-Centric Input: Patients,
Leadership Team (Managers)
Regulatory Oversight and Safety Teams (FDA,CMS,ECRI,AHRQ,IOM)
Financial Management Teams
Grant Writers, Financial Advisors, Sponsors
Start Engine Crowdfunding
Healthcare Expertise and Support Teams
Emergency Response Perspective Teams
Legal and Compliance Teams
Design and Innovation VR,AR Teams
Spaulding CEO, Massachusetts General Hospital, BIDMC, AMR (CFOs,CEO)
MASS Fire Chief, EMS Personnel, AMR, Med Air Care
Patent and Privacy Legal Team
Audi Designers,Bed Manufacturers 3M, Stryker, Siemens, Hill Rom
Specialty Physicians, Medical Researchers
Staff Nurses,Unit Nurses
Zoom MS-Teams Emails Meetings
Open Communi biweekly Stalkholder Daily FeedBack Staff
Legal and Compliance: Patent and Privacy Legal Team and regulatory compliance

List of Learning community: we will involve most from start and adapt our interactions based on project success and needs.

Strategic Approach for Achieving Our SMART Aim

Our approach employs the Plan-Do-Study-Act (PDSA) cycle, a well-established framework for continuous improvement in healthcare.



Plan Phase: (Jan 2025-March2025) We will begin by planning to deploy 12 Six-Sided Beds in the urology unit, assembling and training a team of navigators, and engaging with stakeholders including hospital staff, patients, and regulatory bodies. Key activities will include developing a detailed implementation plan, creating a rigorous health and medication risk analysis questionnaire, and preparing training programs for staff. We will utilize tools like Google Calendars, emails, Zoom, and WhatsApp for effective communication and updates, and we will work to secure regulatory approvals for compliance with healthcare standards.

Do Phase:(April 2025-June2025) During this phase, we will implement the bed system, conduct training sessions, and initiate the pilot project. Our focus will be on achieving the fall reduction aim through the deployment of advanced bed and its tools features and gathering feedback from staff and patients. We will monitor performance metrics, including fall incidents and injury reports, to ensure the system meets our objectives.

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Study Phase: (July 2025-Sep 2025) We will evaluate the effectiveness of our interventions by analyzing data on falls and injuries, reviewing the effectiveness of our startegies, and assessing feedback from stakeholders. If improvements are not effective, we will refine our strategies esp. the questionnaire based on data and feedback while keeping the core bed design and tools consistent or abandon the project if we don't see any improvement in falls and injuries despite continuous efforts.

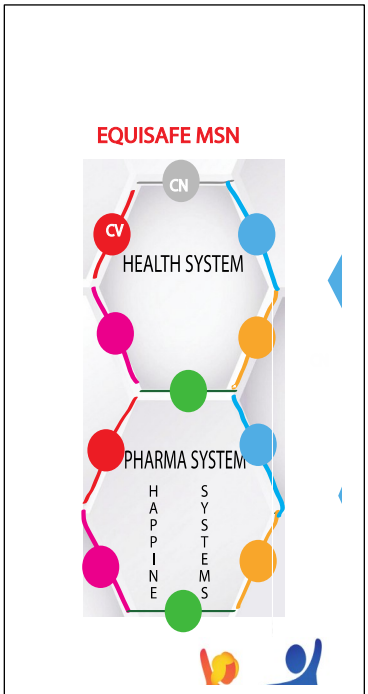
Act Phase: (Oct 2025-Dec 2025) In this phase, we will consolidate our gains and prepare for expansion revise our methods based on the results to sustain. We will focus on scaling successful strategies to other hospital units and regions, ensuring ongoing stakeholder engagement, and planning for future market opportunities.

AI-Driven Fall Risk Assessment Questionnaire Development

To ensure comprehensive and effectiveness of questionnaire, we will involve diverse group from our learning community i.e., Physicians, Pharmacists, Data scientist, safety experts, ergonomic specialist. Our fall risk analysis questionnaire will assess health, medication, and emotional well-being, incorporating cultural and anthropometric data for precision. The AI system will continuously evaluate responses, medication effects, and environmental factors, adjusting bed features such as lighting and assistive options to match the patient's risk level. This approach provides real-time support and personalized fall prevention strategies. By refining its assessments over time, the AI will enhance accuracy, ensuring adaptive, patient-specific interventions for improved safety and outcomes.

Few Sections from AI-Driven Fall Risk Assessment Questionnaire Scoring System

Health System	**Central Nervous System (CNS)**
1. Experienced dizziness or lightheadedness past week?	
2. Had episodes of fainting or seizures recently?	
3. Taking medications affecting balance or alertness?	
Cardiovascular System (CVS)	
4. Experienced chest pain or irregular heartbeats recently?	
5. Feel short of breath when lying down or exerting?	
6. Had episodes of low blood pressure recently?	
Skeletal System	
7. Recent fractures or bone injuries?	
8. Chronic joint pain or arthritis?	
9. Can move from lying to standing without assistance?	
Impact of Medications on Fall Risk Score	



CNS Medications (e.g., Benzodiazepines, Antidepressants): +2 points for each affecting balance or sedation.	
CVS Medications (e.g., Antihypertensives, Diuretics): +2 points for each causing dizziness or orthostatic hypotension.	
Skeletal Medications (e.g., Muscle Relaxants): +2 points for each causing muscle weakness.	
Urological Medications (e.g., Anticholinergics): +2 points for each causing frequent bathroom needs or incontinence.	
	Respiratory Medications (e.g., Bronchodilators): +2 points for each causing respiratory distress.
Hofstede's & Hall's Dimensions	Comfort with privacy in living space?
	Consideration of cultural background in care plan?
	Reliance on family for healthcare decisions?
Additional Questions	Falls in past six months?
	Tripping hazards in home environment?
	Fall prevention education or training received?
Integration with AI	Integration of data with AI for fall risk assessment?
Scoring and Risk Assessment	Scoring scale and risk categories?
	Total Score: _____ (0-120 points)
	Low Risk: 0-40 points
	Moderate Risk: 41-80 points
	High Risk: 81-120 points
Recommendations	Recommendations based on total score and medication review by MD

Intervention Setting and Tools

12 Six-Sided Bed Systems in Urology Unit with Key Fob, Integrated EquiSafe Chair, Adaptive Lighting System, Integrated Assistive Devices, pentagonal tables and Ventilation System with drying and temperature regulation system, AI-Driven Fall Risk Assessment questionnaire with Tabloid, Hexagonal Tiles with water sensors and low-intensity lighting: Proxemics Comfort space Design with less obstacles and cutter.

Clinical/Structural Process Flow

The clinical process for our Six-Sided Bed System involves several key stages, each designed to optimize patient safety and care through innovative technology and strategic planning.

1. Patient Admission: Upon a patient's admission to the urology unit, they are assigned to a customized Six-Sided Bed equipped with a key fob. A bellman is assigned to assist the patient with the bed's features and ensure they are comfortable.
2. Bed Features and Interactions: Each bed is designed with specific features for medical, pharma and happiness (social determinants) focus: 1.CNS, 2.CVS, 3. Skeletal, 4.GI, 5. Urology, and 6. Respiratory in antilock wise direction. Fall Risk Analysis Questionnaire will be performed by any staff at admission to urology unit using a tabloid at the end of History taking. The AI-driven system will use the Comprehensive Fall Risk Analysis Questionnaire to assess the patient's fall risk and determine the appropriate bed mode (Pilot Mode, Skier Mode, Athletic Mode).
3. Fall Risk Assessment and AI Recommendations: Based on the patient's risk level, the AI system will adjust the bed's adaptive lighting and provide recommendations for assistive devices after being reviewed and signed by an MD. For high-risk patients, the system will suggest the EquiSafe Chair

detachable from side 4 and 5 of the 6-sided bed system, while moderate-risk patients will be advised to use walking aids, and low-risk patients will be encouraged to move independently.

4. Environmental Management: The bed system includes a ventilation system to regulate temperature and manage moisture, hexagonal tiles in floor of unit and restrooms with embedded water sensors to detect spills, and low-intensity lighting for visibility. **Proxemics Comfort Design ensures sufficient space for movement, and pentagonal tables offer organized storage** free from traditional clutters and obstacles.
5. Emergency Preparedness: The design includes clutter-free storage for medications and emergency tools like CPR and cricothyrotomy kits including the IV pole attached to the Equisafechair. Bellmen will assist with mobility, docking of chair and provide support as needed and update CEO for any immediate needs.
6. Daily Data Collection and Analysis: Data will be automatically collected since its Ai generated and the system is wireless with memories but staff will also collect and report data to leadership (via email or call) on fall incidents, patient satisfaction, staff feedback, and operational efficiency on daily, weekly and monthly basis along with prescheduled meetings with learning community via the communication media and calendars described in the learning community map. This data will be used to evaluate the system’s effectiveness and guide future improvements.
7. Reporting and Future Planning: At the end of every shift of the pilot phase and every 3 months, we will compile a detailed comprehensive report to assess the results against our baseline metrics. We will use this report to plan for future expansion and to refine our system for broader application.

Metrics for Success and Channels for Reporting and Sharing.

To measure the effectiveness of the Six-Sided Bed System, we will utilize a range of quantitative and qualitative metrics: We will share and report metrics through several key channels. Monthly updates will be distributed via email and internal dashboards. Quarterly reviews will feature detailed reports and presentations, and a final comprehensive report will summarize successes, challenges, and recommendations for scaling. Feedback will be collected through follow-up meetings and forms to continuously refine the project and ensure ongoing success.

Pilot Evaluation Metrics

- Fall Rates and Injury Reports: Key metrics for success.
- Patient Feedback and Satisfaction: Assessed through surveys and direct feedback.
- Staff Feedback: Collected through structured feedback mechanisms.
- Operational Efficiency: Evaluated through space management and system performance.
- AI Effectiveness: Analyzed through data from the fall risk assessment tools.

- Environmental Safety: Environmental hazard incidents (slips, trips).

Fall Incident Rates Metric: Number of falls per 1,000 bed-days. Baseline Data: 3–5 falls per 1,000 bed-days (current industry standard). Target: 50% reduction in fall rates during the pilot phase. Method of Measurement: Track fall incidents in the urology unit before and after implementation. Data will be collected from incident reports and hospital records.

Injury Reports Metric: Number of injuries related to bed incidents. Baseline Data: Historical injury data from traditional hospital beds. Target: Achieve a 50% reduction in bed-related injuries. Method of Measurement: Review injury reports from hospital records and analyze the types and severity of injuries before and after implementation.

Patient Satisfaction Metric: Patient satisfaction scores related to bed comfort and safety. Baseline Data: Patient satisfaction scores from current bed systems. Target: Achieve a 20% improvement in patient satisfaction scores.

Method of Measurement: Surveys and feedback forms collected from patients regarding their experience with the Six-Sided Bed System.

Staff Feedback Metric: Staff satisfaction and feedback on the ease of use and effectiveness of the bed system. Baseline Data: Staff feedback on current bed systems. Target: Achieve a 20% improvement in staff satisfaction related to bed design and functionality. Method of Measurement: Surveys and feedback forms collected from staff on their experience with the Six-Sided Bed System.

Operational Efficiency Metric: Time spent on patient care tasks and bed maintenance. Baseline Data: Current time spent on patient care and bed maintenance tasks. Target: Improve operational efficiency by reducing time spent on tasks by 15%. Method of Measurement: Track time spent on various tasks related to bed maintenance and patient care, comparing pre- and post-implementation data.

Fall Risk Assessments Metric: Accuracy and effectiveness of the fall risk assessment tool. Baseline Data: Accuracy of current fall risk assessment methods. Target: Demonstrate a 90% accuracy rate for the AI-driven fall risk assessment tool. Method of Measurement: Evaluate the accuracy of AI-driven fall risk assessments compared to clinical assessments and outcomes.

Environmental Safety Metric: Environmental hazard incidents (slips, trips). Baseline Data: Average incidents reported in the urology unit over the past year. Target: 50% reduction in incidents within 12 months. Why It Matters: Ensures that our design reduces environmental hazards effectively. How to Track: Collect Data: Track incidents before and during the pilot. Review: Compare against the baseline. Adjust: Refine safety measures based on collected data.

Our strategic plan addresses key challenges to ensure the success of our pilot and future expansion:

Challenge: Achieving a 50% Reduction in Falls: We will rigorously test the system, refine strategies, and ensure high effectiveness. **Challenge: High Initial Costs:** We will demonstrate long-term savings and seek financial support through grants and partnerships. **Challenge: User Adaptation**: Comprehensive training and feedback-based improvements will be implemented. **Challenge: Technical Reliability:** Investing in high-quality infrastructure and maintaining strong support partnerships**. Challenge: Data Security and Privacy:** Implementing robust cybersecurity measures. **Challenge: Regulatory Compliance:** A dedicated team will ensure adherence to regulations and prepare for global expansion. **Challenge: Supply Chain Disruptions:** Diversified suppliers and contingency plans will be established. **Challenge: Patient Comfort and Acceptance:** Involving patients in design and gathering ongoing feedback. **Challenge: Environmental Impact:** Using eco-friendly materials and recycling initiatives. **Challenge: Market Competition:** Highlighting unique features and adapting strategies based on trends**. Challenge: Cultural Differences:** Sensitivity training and open communication with stakeholders. **Challenge: Securing Contracts and Approvals:** Developing strong proposals and transparent communication. **Challenge: FDA Approval and Commercialization:** Working with experts for successful approval and market entry.

Sustainability and Scalability

Our pilot project aims not only to achieve a 50% reduction in falls but also to set a benchmark for future success. Following the success of the pilot study, we aim to scale the system to achieve a 90% reduction in falls and injuries on a larger Our scalability strategy includes: **Expanding to Additional Units and States:** Scaling the system based on pilot success. **Subscription Model:** Offering advanced features like personalized health and medication management. Advanced Technologies: Integrating gyroscopes, telemedicine solutions, and AI-driven clinical decision support. **New Designs:** Developing the 8-sided surgery bed, Equisafe Doors, real-time monitoring with wearable technology, non-slip footwear, motion sensors equipped with gyroscopes, water-sensor hexagonal floor tiles, and tools for cultural and communication needs. **Illuminated Hexagonal Floor Tiles:** Guiding patients with low-intensity LED lights **Environmental Management**: Maintaining a clutter-free environment and advanced storage solutions. **Hexagonal EMR Interface:** Streamlining access to patient information, health and medication management. In summary, our approach is designed to achieve our initial goal of a 50% reduction in falls and injuries and to set new standards in hospital care. We are confident that our strategic plan will lead to a successful pilot and pave the way for future expansion and innovation in patient safety and quality.

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